Human Resource Development, Domains of Information Technology Use, and Levels of Economic Prosperity

Jeffrey E. Kottemann
Perdue School of Business, Salisbury University, 1101 Camden Avenue, Salisbury, Maryland 21801. E-mail: jekottemann@salisbury.edu

Kathleen M. Boyer-Wright
Perdue School of Business, Salisbury University, 1101 Camden Avenue, Salisbury, Maryland 21801. E-mail: kmwright@salisbury.edu

ABSTRACT

We report on a research model that was developed and tested to empirically investigate the associations of education quality, on-the-job training, the maturity of information and communications technology (ICT) use by individuals, businesses and governments, and gross domestic product (GDP) per capita across 122 countries. Overall, the findings indicate that education quality is positively associated with GDP per capita, while on-the-job training is not. Education quality is positively associated with ICT use by individuals and governments, but weakly with ICT use by business. On-the-job training, however, is positively associated with all three domains of ICT use. We then separately analyze countries with higher and lower levels of GDP per capita and find both similarities and differences. Healthy composite reliabilities and R^2s are obtained in all analyses. The research model, its analysis, and discussion of the results are presented. © 2008 Wiley Periodicals, Inc.

Keywords: human capital; information technology; economic development

1. INTRODUCTION

In recent socioeconomic development theory and practice, at least two important shifts in emphasis have occurred. One, there is a renewed emphasis on human resource development, which has led to a reemphasis on the role of education and training in economic development (Chacko, 2005). Two, the importance of information and communication technologies (ICT) utilization has been recognized as key to the modernization of socioeconomies (Baliamoune-Lutz, 2003), (Corea, 2007). Indeed, recent ICT trends such as e-business and e-government have been cited as routes to wealth creation (Amit & Zott, 2001) and economic growth (Baliamoune-Lutz). However, the proper roles and actual effects of information technology in dynamics of socioeconomic development remain controversial. Indeed, it has been argued that "economic and social theory converge to the suggestion

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that ICT diffusion and intensification of information activities do not lead deterministically to economic growth (Avgerou, 1998, p. 15)." Empirically, there have been ambiguous findings regarding the effects of education on ICT diffusion and the effects of ICT use on economic prosperity, particularly in developing countries (Baliamoune-Lutz). Therefore, it is important to conduct global investigations into the roles and interplay of human resource development, ICT usage in the domains of citizens, business, and government, and national economic prosperity.

We develop and test a research model that empirically investigates the associations of education quality, on-the-job training, ICT use maturity in three domains (individual, business, and government), and gross domestic product (GDP) per capita across 122 countries (see Appendix A for the list of countries). Specifically, we look at the statistical direct associations of education quality and of on-the-job training with ICT usage by individuals, business, and government, and with nations' GDP per capita. We also look at the indirect associations of education quality and on-the-job training with GDP per capita through nations' levels of individual, business, and government ICT use.

Our research propositions and corresponding model are tested using country-level data made available by the World Economic Forum (WEF), the International Telecommunications Union (ITU), and the World Bank, covering 122 countries. For analysis, this sample size is too small relative to the number of model parameters to test the model using a maximum likelihood structural equation modeling technique, and so we use partial least squares (PLS) for predictive, exploratory analysis. All constructs (latent variables) have very good composite reliability scores (all greater than .9), many important model paths are significant, and the R^2s for the four endogenous variables—the three ICT use domains of individual, business, and government, and GDP per capita—are healthy. Overall, the most pronounced effects are the direct association of education quality and on-the-job training with a majority of ICT usage domains. This is the case for both countries with higher and lower levels of GDP per capita analyzed separately and overall. Group differences occur for direct associations with GDP per capita where education quality is significant in higher levels of GDP per capita countries and on-the-job training is significant in lower levels of GDP per capita countries. However, the associations of ICT usage with GDP per capita are found to be weak, with the exception of e-government.

2. RESEARCH MODEL DEVELOPMENT

Figure 1 illustrates our model outlined above. Hypotheses are stated formally at the end of this section. The model depicts direct and indirect effects of two multi-item constructs: Education Quality and On-the-Job Training. The data items for each construct are from a survey conducted by the WEF as a part of their work on the *Global Competitiveness Report 2006–2007* (Lopez-Claros, Schwab, & Porter, 2007). The survey gathers information on a broad range of variables for which hard data sources are scarce or, frequently, nonexistent. WEF then reports the mean response for each questionnaire item for each country. (Details on the WEF survey and process are given in Appendix B.) Composite reliabilities for all constructs that we make from individual survey items are high and are reported in the Results section. Factual data made available by the ITU and the World Bank are also used. More detail is given in the Measures section below.

First, we are exploring whether higher levels of education quality and on-the-job training are associated with ICT use and with higher levels of GDP per capita. The level of national

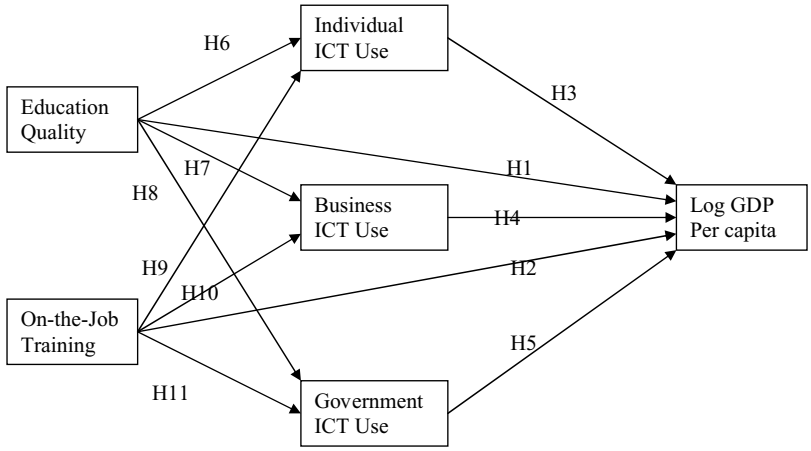

Figure 1 Our theoretical model.

human capital appears to be strongly associated with computer adoption (Caselli & Coleman, 2001). Also, "education and training are decisive in national competitive advantage. [They] constitute perhaps the single greatest long-term leverage point (Porter, 1990, p. 628)." Thus, one aspect of our research model looks for direct associations of these two latent variables with ICT use and GDP per capita.

Second, it has been convincingly argued that the application of ICT offers phenomenal opportunities for wealth creation and is key to the modernization of economies—see, e.g., Amit and Zott, 2001, Baliamoune-Lutz, 2003, Chacko, 2005, and Qureshi, 2005. Thus, we include multi-item measures of ICT usage for three critical domains: individual ICT use, business ICT use, and government ICT use. We are interested in the direct associations of ICT usage with GDP per capita as well as the indirect associations of education quality and on-the-job training on GDP per capita through the three Internet usage domains. That is, we investigate the intervening role of these three ICT usage domains on the relationship between education quality and on-the-job training and GDP per capita. Stating the above-mentioned as formal, directional hypotheses gives as follows:

H_1 Education quality is positively associated with GDP per capita.
H_2 On-the-job training is positively associated with GDP per capita.
H_3 Individual ICT use is positively associated with GDP per capita.
H_4 Business ICT use is positively associated with GDP per capita.
H_5 Government ICT use is positively associated with GDP per capita.
H_6 Education quality is positively associated with the extent of individual ICT use.
H_7 Education quality is positively associated with the extent of business ICT use.
H_8 Education quality is positively associated with the extent of government ICT use.
H_9 On-the-job training is positively associated with the extent of individual ICT use.
H_{10} On-the-job training is positively associated with the extent of business ICT use.
H_{11} On-the-job training is positively associated with the extent of government ICT use.

Positive indirect associations hypothesized are as follows:

H_{12} Education quality → Individual ICT use → GDP per capita.
H_{13} Education quality → Business ICT use → GDP per capita.
H_{14} Education quality → Government ICT use → GDP per capita.
H_{15} On-the-job training → Individual ICT use → GDP per capita.
H_{16} On-the-job training → Business ICT use → GDP per capita.
H_{17} On-the-job training → Government ICT use → GDP per capita.

3. MEASURES

Data was obtained by measures used by the WEF, the Telecommunications Union, and the World Bank for 2006. They include *mean responses* for each of the 122 countries, surveying over 11,000 professionals for the WEF Executive Opinion Survey. The survey items use seven-level response scales. WEF conducts rigorous quality control procedures to insure not only "clean data" but also data that reflect the standing of countries in a global perspective. Thus, their data are highly comparable across countries. Factual data for individual usage factors were obtained from the ITU. (Appendix B provides additional details.) For GDP per capita, we used the figure for each country supplied by the World Bank. As is standard practice, the log transform is used to normalize its distribution.

Labor economists have argued that measuring education must include notions of quality rather than, for example, simply using measures such as spending (Griliches, 1997). We take this view here and with our chosen measures of education.

Education quality is derived from the following WEF survey items:

- Internet access in schools is (1 = *very limited*, 7 = *extensive*; most children have frequent access).
- The educational system in your country (1 = *does not meet the needs of a competitive economy*, 7 = *meets the needs of a competitive economy*).
- Management or business schools in your country are (1 = *limited or poor quality*; 7 = *among the best in the world*).
- Math and science education in your country's schools (1 = *lag far behind most other countries*, 7 = is *among the best in the world*).
- The public (free) schools in your country is (1 = *poor quality*, 7 = *equal to the best in the world*)

On-the-job training is derived from the following WEF survey items:

- Specialized research and training services in your country is (1 = *not available*, 7 = *available from world-class local institutions*).
- The general approach of companies, in your country, to human resources is to (1 = *invest little in training and employee development*, 7 = *invest heavily to attract, train and retain employees*).

Individual ICT use is derived from the following ITU items:

- Personal computers per 100 inhabitants.
- Total broadband Internet subscribers per 100 inhabitants.
- Internet users per 100 inhabitants.

Business ICT use is derived from the following WEF survey items:

- In your country, companies use the Internet extensively for buying and selling goods and services and for interaction with customers (1 = *strongly disagree*, 7 = *strongly agree*).
- Mobile or cellular telephones for your business are (1 = *not available*, 7 = *just as accessible and affordable as in the world's most technologically advanced countries*).
- Companies in your country are (1 = *not able to absorb new technology*, 7 = *aggressive in absorbing new technology*).

Government ICT use is derived from the following WEF survey items:

- In your country, online government services such as personal tax, car registrations, passport applications, business permits and e-procurement are (1 = *not available*, 7 = *extensively available*).
- In your view, ICT use by the government has improved the efficiency of government services and has facilitated interaction with business and civil society (1 = *strongly disagree*, 7 = *strongly agree*).
- The presence of ICT in government offices in your country is (1 = *very rare,* 7 = *commonplace and pervasive*).

4. RESULTS

PLS analysis is performed using SmartPLS (Ringle, Wende, & Will, 2005). The sample size precludes maximum likelihood structural equation modeling, and so PLS is used for exploratory path analysis using the standardized coefficients scheme as well as bootstrapping with cases of 500 and with 1000 iterations for significance testing. Note that PLS mitigates multicollinearity concerns extant with ordinary least squares (OLS) regression. Figure 2 shows a path analytic schematic of the theoretical model with the statistical analysis results across all 122 countries. The composite reliabilities for our constructs (latent variables) given in the preceding section are strong, with all being greater than 0.9. R^2s are also generally strong and are shown on all figures. To highlight the paths corresponding to our supported hypotheses, the paths, their standardized coefficients, and their significance levels appear in boldface type in each figure. Only the paths that are statistically significant *and* that have standardized path coefficient greater than 0.2 appear in boldface type because that minimum level suggests practical significance (Chin, 1998). Paths that are marginally significant statistically or practically are shown with medium-boldface type arrows.

Looking at Figure 2, the significant associations of education quality are several. Not only is there a direct association with GDP per capita, there is also an indirect association with GDP per capita through government ICT use. Education quality also has a direct association with individual ICT use and a marginal association with business ICT use. On-the-job training has direct associations with all the ICT usage domains—individual, business, and

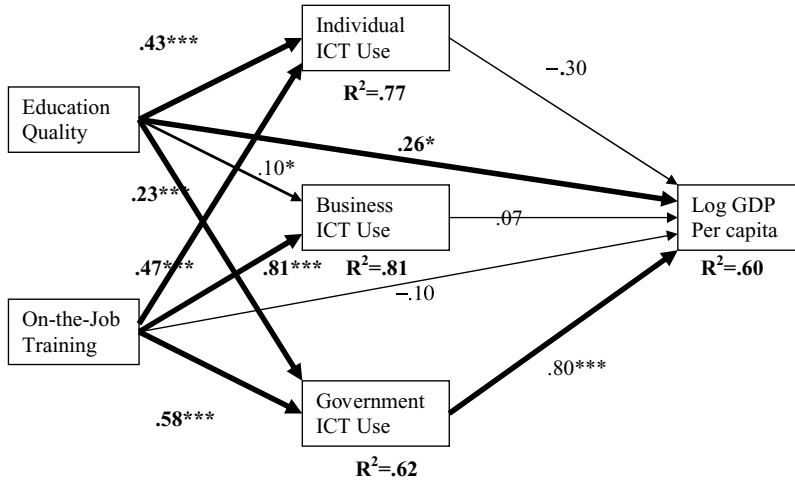

Figure 2 Model analysis results for all 122 countries with path coefficients, significance levels, and R^2s.

government—and an indirect association with GDP per capita through government ICT use.

ICT diffusion and adoption vary between developed and developing countries (World Bank, 2008). As such, we next explore the differences between developed and developing countries. To do so, we partitioned the 122 countries into two groups based on the median GDP per capita and analyzed each group separately. Figures 3 and 4 show the results for the higher and lower GDP groups. Looking at the boldface paths, it is evident that some important paths are common between groups: Both education quality and on-the-job training positively affect all three ICT usage domains, although the path coefficient from education quality to business ICT use is relatively weak. This is a very important finding as it indicates that human resource development through education and training may indeed lead to strong modernization forces through information technology use across all usage domains and for countries at various stages of economic development. There is, however, a very interesting difference between the two groups. Whereas education quality—not on-the-job training—has a direct association with countries with higher levels of GDP per capita, on-the-job training— not education quality—has a direct association with countries with lower levels of GDP per capita.

5. DISCUSSION AND CONCLUSIONS

Table 1 summarizes the results. It is evident that the results are fairly consistent using all countries and using countries separately considered based on higher and lower GDP per capita grouping. Both education quality and on-the-job training appear to be powerful catalysts for the modernization of economies via ICT use by individuals, business, and government. This is contrary to Baliamoune-Lutz (2003) who found that ICT diffusion was not related to education in developing countries (cf. Pick & Azari, 2008). However, it must be kept in mind that our measure of education explicitly addresses the quality thereof and that our measures of education, training, and ICT diffusion across three domains are more extensive. Further, our analyses involve more countries and at a more recent point in time.

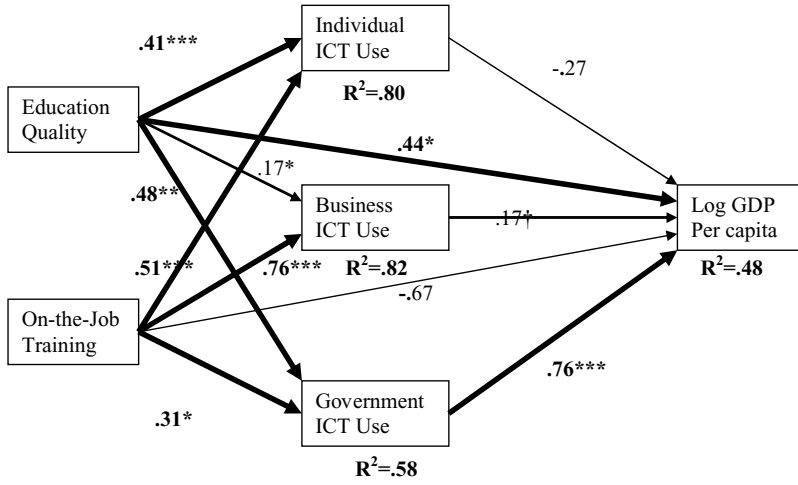

Figure 3 Model analysis results for higher GDP per capita (61) countries with path coefficients, significance levels, and R^2s.

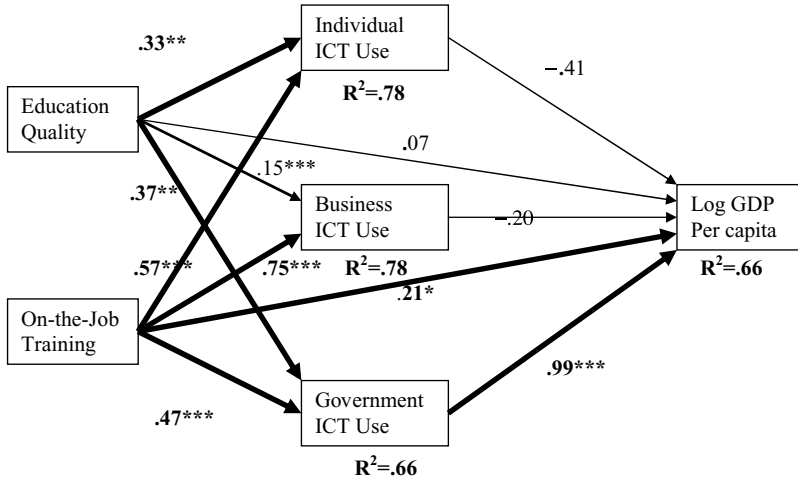

Figure 4 Model analysis results for lower levels of GDP per capita (61) countries with path coefficients, significance levels, and R^2s.

The direct associations of education quality and on-the-job training with GDP per capita depend upon whether countries have higher or lower levels of GDP per capita. This interaction effect is interesting and may reflect a reality where richer countries can afford to invest in formal educational systems and their citizens are better able to attend such schooling. Poorer countries, on the other hand, may need to rely on work at an earlier age and to depend upon employers for training; relatedly, if public education is weak, then business enterprises must pick up the slack through on-the-job training to improve and hold their competitiveness. Finally, looking at the R^2s for GDP per capita, it is evident that the model explains GDP per capita best overall and for lower levels of GDP countries, and next for higher levels of GDP countries. Nonetheless, the model explains variance in ICT use across the domains of individuals, business, and government quite well and consistently.

TABLE 1. Summary of Results: Significance Statistically and Practically?

Hypothesis	Overall?	Higher-GDPs?	Lower-GDPs?
1	Yes	Yes	No
2	No	No	Yes
3	No	No	No
4	No	Marginal	No
5	Yes	Yes	Yes
6	Yes	Yes	Yes
7	Marginal	Marginal	Marginal
8	Yes	Yes	Yes
9	Yes	Yes	Yes
10	Yes	Yes	Yes
11	Yes	Yes	Yes
12	No	No	No
13	No	Marginal	No
14	Yes	Yes	Yes
15	No	No	No
16	No	Marginal	No
17	Yes	Yes	Yes

Previously, we have addressed the aspects of our model regarding supported hypotheses (model paths), but it is worthwhile to look at what hypotheses were not supported. Individual and business ICT use are not positively associated with GDP per capita overall or for higher or lower levels of GDP per capita countries, although the business ICT use to GDP link is marginally significant both statistically and practically for higher levels of GDP countries. While this is somewhat consistent with the argument cited in the Introduction that "economic and social theory converge to the suggestion that ICT diffusion and intensification of information activities do not lead deterministically to economic growth (Avgerou, 1998, p. 15)," it is important to note that in post hoc analysis the *bivariate* correlation coefficients between LnGDPpc and the other PLS-generated latent variable scores range from 0.47 to 0.76 when considered in isolation. Each is significant ($p < 0.001$).

		BICTU	Edu	GICTU	IICTU	Training
LnGDPpc	Pearson Correlation	.627	.569	.756	.474	.565

It is important to point out several limitations of this research. First, PLS is best suited to exploratory analysis as a prelude to a robust interpretive technique such as maximum likelihood structural equation modeling (Garson, 2008). However, our small sample size (122) relative to the number of model parameters disqualifies a maximum likelihood structural equation modeling technique. Thus, the present research should be considered exploratory. Second, as previously discussed, the measures used in this research are broad indicators. Nevertheless, they are very useful in painting a global picture. Although they should not be considered a sole source of information on the issues investigated here, they certainly provide a broad perspective that can serve as a direction for additional detailed analysis. Third, as this study uses cross-sectional data, it is unwise to draw firm cause-and-effect conclusions. Future longitudinal research is needed to clarify the issues raised here. Relatedly, the lack of significant associations between certain factors in the path analytic model concern only one year in time. If indeed a lag effect is extant, then we might expect these associations to become more significant in time-series analysis.

APPENDIX A

List of Countries

Algeria
Albania
Angola
Argentina
Armenia
Australia
Austria
Azerbaijan
Bahrain
Bangladesh
Barbados
Belgium
Benin
Bolivia
Bosnia & Herzegovina
Botswana
Brazil
Bulgaria
Burkina Faso
Burundi
Cambodia
Cameroon
Canada
Chad
Chile
China
Colombia
Costa Rica
Croatia
Cyprus
Czech Republic
Denmark
Dominican Republic
Ecuador
Egypt
El Salvador
Estonia
Ethiopia
Finland
France
Georgia
Guatemala
Guyana
Honduras
Hong Kong SAR
Hungary
Iceland
India
Indonesia
Ireland
Israel
Italy
Jamaica
Japan
Jordan
Kazakhstan
Kenya
Korea, Rep.
Kuwait
Kyrgyz Republic
Latvia
Lesotho
Lithuania
Luxembourg
Macedonia, FYR
Madagascar
Malawi
Malaysia
Mali
Malta
Mauritania
Mauritius
Mexico
Moldova
Mongolia
Morocco
Mozambique
Namibia
Nepal
Netherlands
New Zealand
Nicaragua
Pakistan
Panama
Paraguay
Peru
Philippines
Poland
Portugal
Qatar
Romania
Russian Federation
Serbia and Montenegro
Singapore
Slovak Republic
Slovenia
South Africa
Spain
Sri Lanka
Suriname
Sweden
Switzerland
Taiwan, China
Tanzania
Thailand
Trinidad and Tobago
Tunisia
Turkey
Uganda
Ukraine
United Arab Emirates
United Kingdom
United States America
Uruguay
Venezuela
Vietnam
Zambia
Zimbabwe

APPENDIX B

The World Economic Forum—Executive Opinion Survey

Recognizing the critical role of ICT in economic development, the Center for International Development at Harvard University developed the Network Readiness Index (NRI). First introduced in the 2001–2002 *Global Information Technology Readiness* (*GITR*) report, which serves as the technological component of the *Global Competitiveness Report* published annually by the World Economic Forum, the NRI is defined as follows: "the degree of preparation of a nation or community to participate in and benefit from ICT developments." The NRI was refined further by the Institut Européen d'Administration des Affaires (INSEAD). The current index includes nearly 70 quantitative and qualitative variables combined to form subindices of network use and enabling or environmental factors.

The Executive Opinion Survey developed jointly by The World Economic Forum and Harvard University's Center for International Development and Institute for Strategy and Competitiveness cover qualitative measures. The survey gathers information on a broad range of variables for which hard data sources are scarce or, frequently, nonexistent (Lopez-Claros et al., 2006). For each country, a Partner Institute is selected to conduct the Executive Opinion Survey among a representative sample of business and government leaders in their respective countries. These leaders are chosen based upon not only their broad familiarity with the current conditions in their countries but also their knowledge and experience of the global environment. Over 11,000 responses were received for the 2006–2007 report. The survey dataset undergoes a thorough verification process aimed at excluding blatant outlying responses and responses from very small companies which might have difficulty comparing their operating environment to a global standard. Also, potential perceptual bias is mitigated through reliability analyses, which includes distributional testing and triangulation with related objective measures.

Sample sizes per country are purposefully varied according to the size of the economy. At least 30 responses were received per country, with 93% of the countries having 50 or more respondents. The response rate was 97%. The *GITR* reports results as the *mean value of each measure for each country*. The overall data is used by numerous organizations for many purposes, such as the US Agency for International Development (USAID), which uses it as a guide in promoting long-term and equitable growth in countries worldwide and in monitoring their progress.

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Jeffrey E. Kottemann *received his PhD from The University of Arizona in 1984. He was assistant professor at The University of Hawaii, Manoa, associate professor at The University of Michigan, Ann Arbor, and is professor of Information and Decision Sciences at the Perdue School of Business at Salisbury University where he was department chair from 1994 to 2006.*

Kathleen M. Boyer-Wright *is associate professor of Information and Decision Sciences at the Perdue School of Business at Salisbury University. She received her PhD from The George Washington University in 2004. She is a CPA and CMA and has worked for over 20 years in both the public and the private sectors.*